THE AERONAUTICAL JOURNAL.

JULY, 1897.

The Aeronautical Journal.

(PUBLISHED QUARTERLY.)

SUBSCRIPTION PER ANNUM (post free), 8s.

Communications respecting Advertisements to be addressed to the Publishers, "Aeronautical Journal,"

Messrs. KING, SELL, & RAILTON, Ltd., 4, Bolt Court, 12, Gough Square, and 4, Birchin Lane, E.C.

ADVERTISING TERMS:—10/- Per Inch, Single Column.

NOTICES OF The Aeronautical Society.

A Meeting of the Council was held on June 10th.

The following gentlemen were elected Members of the Society—

COLONEL H. ELSDALE, R.E.

MR. JOHN MARSHALL.

MR. W. G. D. GOFF.

MR. LAWRANCE HARGRAVE.

MR. THOMAS MACDONALD.

B. BADEN-POWELL, CAPT.,
Hon. Sec.

Flight and Flying Machines—Recent Progress.

As considerable progress has been made in solving the problem of flight during the past few years, a short account of the present condition of affairs may be of interest.

For convenience sake the subject will be divided into the following sections:—(1) The air and its relation to flight. (2) The methods of measuring the air force. (3) The forces acting on a body in flight, and the conditions of equilibrium. (4) The stability of flying bodies. (5) The power required for flight. (6) The flight of birds and insects. (7) The principles of propulsion. (8) Fuel. (9) Motors. (10) Materials for construction. (11) Design of flying machines. (12) The flying machine in peace. (13) The flying machine in time of war.

(1) THE AIR, AND ITS RELATION TO FLIGHT.

The general nature of the air, its composition, motions, etc., have long been known, but it is only recently that the part played by it in flight has been realized.

Briefly, it may be said that the functions of the air as regards flight are two, viz., to supply a force which will support the weight of the body, and to furnish a force which, when combined with that applied to the propelling instrument, will overcome the resistance to the forward motion of the body. For instance, in the Maxim flying machine, the vertical component of the total air pressure forms the supporting force, while the force applied to the propellers, combined with the re-action of the air, furnishes the power required to overcome the horizontal component, and drive the machine along.

As regards the air itself the principal point to notice about it is its changeableness. Not only the strength of the air force, but also its direction and point of application, are subject to very rapid changes. For instance, in even moderate gales, great changes take place in the force of the wind, while at almost any time the friction of the air against the rough surface of the earth causes the direction of the air currents to vary very considerably. Again, at the equator, the heat of the sun forms vertical currents which materially assist birds in certain kinds of flight, while even in a horizontal wind the angle at which a flat plane is placed causes very great variations in the position of the centre of pressure, or point of application of the air force.

It is evident, therefore, that an accurate knowledge of the action of the air under varying circumstances is of the highest importance, and

(2) THE METHOD OF MEASURING THE AIR FORCE

will now be described. First of all, as to what is meant by the air force. Suppose a plane one square foot in area ($1' \times 1'$) inclined at an angle of 30°, to be driven horizontally through the air; then it will be found that the air pressure on the upper side of the plane is less than the air pressure on the lower side, and that

consequently there will be a resultant air force pressing the plane upwards and backwards. This resultant air force is what we require to know, and in order to measure it, very accurate and careful experiments have to be carried out.

Speaking generally, it may be said that there are two ways of testing air pressure, viz., the "Open Air Method" and the "Still Air Method." In the former the body, the effect of air upon which it is desired to test, is fixed in suitable apparatus, and exposed to the action of the wind. Accurate recording apparatus is then employed to find the point of application, direction, and magnitude, of the air force under different circumstances, and thus the effect of the air on the body in question is found. In the "Still Air Method" the body to be tested is made to travel in a straight or circular path in still air, and the necessary measurements taken, as explained above. The great objection to the former method is the difficulty of obtaining accurate results, owing to the constant changes of the wind's direction, and most experimenters are now in favour of carrying out experiments by the second method, which gives better results, though requiring larger and more expensive apparatus. A very complete description of the "Still Air Method" of working is given in "Experiments on Aerodynamics," by Prof. Langley, of the Smithsonian Inst., U.S.A.

As regards the results of experiments, the following is a brief summary of the most satisfactory ones to the present date:—

Centre of Pressure, or Point of Application of the Air Force.

(*a*) *Flat Planes.*—Position varies considerably with the angle the plane makes with its path. If angle = 90° C. of P. is at centre of surface; when the angle is small, say 5° or so, the C. of P. is about $\frac{1}{4}$ of the length of the surface from the front edge.

(*b*) *Curved Surfaces.*—With small surfaces, having a curvature of $\frac{1}{12}$, the C. of P. remains nearly constant in position, viz., at about $\frac{1}{3}$ of the length from the front edge for angles between about 0° and 60°. In triangular shaped surfaces, base foremost, the C. of P. coincides nearly with the centre of gravity at angles between 0° and 60°, a very important fact, as will be seen when discussing the flight of birds.

(*c*) *Bodies.*—No very satisfactory results as yet obtained. With what are called "fair shaped" bodies, there is probably very little change of position of the C. of P. at angles between 0° and 60°.

Line of Action of the Air Force.

(*a*) *Flat Planes.*—For an indefinitely thin plane the line of action is perpendicular to the surface; but if the plane has even a small thickness, the line of action varies very considerably from the perpendicular at small angles. The reason of this is that the pressure on the head of the plane (viz., the thickness) is large in comparison with the pressures on the upper and lower surfaces, and consequently the line of action of the resultant air pressure is thrown back from the perpendicular.

(*b*) *Curved Surfaces.*—The position of the line of action in these cases is so variable that it must be found experimentally in order to get satisfactory results.

(*c*) *Bodies.*—Very few results as yet published. With "fair shaped" bodies the line of action is probably nearly perpendicular to the major axis, at angles between 0° and 30°.

Magnitude of the Air Force.

(*a*) *Flat Planes.*—When perpendicular to path of motion, $p = \cdot 00166 V^2 S$ is the formula given by Langley, and this he considers correct to within about 10 per cent. For inclined planes Langley found Duchemin's formula $P = B' \frac{2 \sin \alpha}{1 + \sin^2 \alpha}$ suitable (see Chanute's *Progress in Flying Machines*).

(*b*) *Curved Surfaces.*—The best results published are those given by Lilienthal (see *Der Vogel flug*), who experimented with wing-shaped surfaces having a $\frac{1}{12}$, $\frac{1}{15}$, etc., curvature. The shape of the surface, and the amount of curvature, affect the pressures so much that experiment is absolutely necessary to get good results.

(*c*) *Bodies.*—Very few results published, but it is quite clear that "fair shaped bodies" immensely reduce the resistance to forward motion; in fact, with some shapes, when moving horizontally, the forward resistance is indefinitely small.

The above are some of the results obtained experimentally with the usual class of testing apparatus, but it appears desirable to draw attention to a theory of the movement of bodies through fluids, called the "Stream Line" theory, which seems to be of great importance in connection with this subject.

When a weightless body of stream line form moves through a frictionless fluid it has been shown by Froude that the resultant air force on it = 0, and that consequently, since no other force acts on it, if it is once put in motion it will move on for ever. Now air is practically frictionless, and the body of a bird is approximately of the stream line form; consequently, supposing its weight to be borne by the wings, this stream line theory shows that the *body* of the bird will, at even high velocities, have only a very small resistance to overcome, and that no very great power *can* be required to propel it. A similar argument applies in the case of the wings of the bird, which are simply slightly curved surfaces, so formed that at any given velocity the vertical component of the air pressure acting on them

balances the weight of the bird, while the horizontal component forms a small forward resistance, which together with the small body resistance above described, are the only forces which the bird has to overcome.

It this theory is correct, it will be seen that it explains what has so long puzzled all experimenters, viz., how such a small creature as a bird could apparently exert so much power. The real fact, of course, is that owing to its form, very little power is required, and that consequently the bird is not extraordinarily powerful, as has often been supposed.

Before leaving this part of the subject it is desirable to point out to experimenters the importance of accurately recording the forms and dimensions of the bodies they test, as great differences in results have been obtained, owing to some such matter as the thickness of a surface, etc., not having been taken into account.

(3) The Forces Acting on a Body in Flight and the Conditions of Equilibrium.

There are really only two kinds of flight, viz., "Driving Flight" and "Soaring Flight," the former being exemplified by a bird moving along flapping its wings, the latter by the soaring birds, which move along on motionless wings.

In driving flight three forces act upon the body, viz., the air (at rest or in motion), the weight, and the driving force, and it is evident that in order to keep the machine in any particular path and move it with a constant velocity, the following conditions must be fulfilled:—

1st. The forces perpendicular to the path must $= 0$.

2nd. The forces along the path must $= 0$.

3rd. All the forces must act through the centre of gravity of the machine.

As will be seen further on, the great difficulty in designing a machine is to insure the centre of pressure, or point of action of the air force, always coinciding with the centre of gravity, there being of course no difficulty in making the other two forces act through the same point.

Next, as regards "Soaring Flight," similar rules hold good, but in this case there is no artificial driving force, and consequently the propelling force must be got by suitably combining the other two in such a manner that their resultant always acts in a forward direction.

This is done either by altering the inclination of the sustaining surface, or by using a rudder to steer the machine up and down in a vertical plane, precisely as a ship's rudder moves it to right or left in a horizontal plane.

In still air a body cannot be made to rise above its original level by soaring flight, but when the air is in motion it seems possible, by suitable steering (viz., taking proper advantage of the wind), to attain any level, and to continue the motion of the machine indefinitely.

Soaring flight is of the greatest importance; partly because it is steadily practised by certain kinds of birds, but chiefly because it shows how safe alighting (the most difficult act of flight) can be accomplished. By steering as above explained, a machine can be brought to the ground with little or no vertical velocity (the first consideration), while as regards horizontal velocity, this can always be made a minimum by designing the machine in a suitable manner.

(4) The Stability of Flying Bodies.

The next point to consider is how to ensure the "stability" of a flying body. By "stability" is meant the power which a machine or body must possess of always righting itself if temporarily displaced from its normal position by a force which tends to overturn it. For example, suppose a sudden change in the direction of the wind from, say, the horizontal, to -60 ; this will at once cause a change not only in the direction of the air force acting on a body, but also in its point of application, and consequently, if the body is badly designed, may overturn it.

Next, as regards the different classes of stability. It is evident that the body must be stable in all three planes, viz., the horizontal plane, the vertical longitudinal plane, and the vertical transverse plane, the planes being taken as passing through the centre of gravity of the body and its path.

As regards the horizontal plane, stability cannot be automatic; some kind of rudder or steering apparatus must be used. In the marine ship a vertical rudder or twin screws are found suitable, and for the aerial ship the arrangements will be similar.

In the vertical longitudinal plane stability must be automatic, that is to say, if the air ship is temporarily moved out of its normal position, it must return to it as soon as the moving force has ceased to act. To ensure this the centre of gravity of the body should be kept well below the centre of pressure of the sustainer.

In the vertical transverse plane stability must also be automatic, and this can be arranged for as explained for the vertical longitudinal plane.

The question of stability is of the highest importance; probably 90 per cent. of the failures in attempts at flight have been due to the neglect of the study of this part of the subject.

(5) The Power Required for Flight.

The power required for flight has usually been very much over-estimated; for instance, in the case of birds some most absurd calculations have been worked out, giving the power exerted by them as many hundred times greater than its real value.

As explained above, there are really only two kinds of flight, viz., soaring flight and driving flight, and it is desirable to consider them separately.

In soaring flight, the only forces acting on the body are its weight and the air; no artificial force acts on it; and flight of this class is based solely upon skilfully combining the weight and air forces. As a consequence, no artificial force whatever, or, in other words, no power, is required for soaring flight, and provided the wind (or air force) is suitable, and proper arrangements are made for combining it with the force of the weight, there is nothing to prevent this class of flight being carried on indefinitely without any artificial aid whatever.

In driving flight the conditions are different. Here two forces have to be developed, viz., the sustaining and the driving force. The most suitable way of doing this seems to be to use either a large sustaining surface, as done by Maxim, or to construct the machine on the lines of Phillips, and use a large number of small surfaces, something like the slats of a Venetian blind. Then, in order to sustain the body in a horizontal path, and drive it along with constant velocity—

Sustaining force (vertical component of the air force) . . . . = Weight = W,
Driving force . . . . = Horizontal component of the air force = R,

and the power required to drive and sustain the body at constant velocity V

$$= \frac{RV}{550} \text{ H.P.},$$

using the ordinary units of measurement.

Of course, in order to vary the velocity, the movement of the mass must be taken into consideration, as would be done in the case of a body moving along the earth's surface.

(6) The Flight of Birds and Insects.

The flight of birds and insects has always been of the greatest interest to aviators, but it is only of late years that the true principles of their movements have been discovered. The bird or insect is a true flying machine—the wings forming the sustainer and propelling instrument, the body corresponds to a car, the feet are the rising and alighting apparatus, while the food is of course the fuel which, so to speak, drives the engine (the muscles of the wings).

As regards the bird, a great deal of information as to size, dimensions, weight, etc., is available, owing to the researches of Mouillard, Chanute and others, and the following details are of interest, as they give some sort of idea of the probable dimensions of the flying machines of the future:—

Sustaining Surface.—The weight carried per square foot of wing surface of some of the principal birds is a follows:—

Swallow	.276 lbs.
Gull	.435 ,,
Rook	.575 ,,
Duck	1.158 ,,

(See "Progress in Flying Machines") (Chanute).

Motors, viz., pectoral muscles = from $\frac{1}{4}$ to $\frac{1}{3}$ of the total weight of the bird.

Power Developed.—Penaud gives the following:—

Peacock . . 1 H.P. per 66 lbs.
Pigeon . . . 1 H.P. per 57 lbs.
Sparrow . . 1 H.P. per 48½ lbs.
} per total weight.

For a gull Chanute gives 82½ lbs., but this is probably an over-estimate, as the body resistance was taken rather high.

It is interesting to notice that the Maxim flying machine was required to develop about 1 H.P. for every 50 lbs. of the total weight of machine fully loaded.

The different flight manœuvres of birds may now be briefly described.

Starting.—There are two modes of starting, viz., running along the ground, flapping the wings and jumping into the air, and springing into the air from a perch. The former is much the hardest work, and some of the heavier birds have great difficulty in carrying it out; in fact, many of them do not come down to the ground level at all if they can avoid it.

A flying machine will have to start somewhat after the first method, and will as is easily understood, have to exert its greatest power at that time.

Turning in the Air.—To effect this the bird raises its wing, on the side to which it desires to turn, and also inclines its weight slightly to that side.

Gliding.—This form of flight is often mistaken for "soaring," because the bird holds out its motionless wings exactly as it does in the latter kind of flight. What really happens is that the unexpended energy ($\frac{1}{2}mV^2$) is utilized, usually to glide down a gentle slope of about $\frac{1}{10}$ or so, though it is possible for the bird to rise above its original position by increasing the angle of inclination of its wings.

Soaring has been explained above; it depends merely on the skilful combination of the air and weight forces. It may be noticed here that, according to Lilienthal, when a soaring bird holds its wings out horizontally, the line of action of the air force lies in front of a vertical line through the centre of pres-

sure, and consequently there is a *forward resultant* force, which drives the bird along. Further experiments on this point are much required.

Hovering.—In this case the bird faces the wind, holds its body nearly vertical and remains still in the air, except that it beats its wings more or less vertically up and down. This manœuvre requires a good deal of exertion, and can only be performed in a high wind.

Alighting.—This is done by ceasing to flap the wings, inclining the body nearly vertically, and spreading the wings out at a steep angle of inclination. When the ground is reached the bird usually runs a few steps, so as to destroy its horizontal velocity. Flying machines will alight upon very much the same principle; they will be steered to the earth as explained above, and then stopped by the friction of the ground on their landing wheels.

The flight of insects is not so important as that of birds, as it is often very irregular and not suited for flying machines. There is also considerable difficulty in obtaining satisfactory data as to the power exerted by insects, owing to their small size and delicate construction, which do not allow of accurate measurements. Lucy has, however, made some researches into this branch of the subject, and ascertained for a few insects, the ratio of weight to surface, etc. (See Chanute's "Progress in Flying Machines.")

(7) The Principles of Propulsion.

In order to provide the "Driving Force" which gives the forward and sustaining motions in "Driving Flight," it is necessary to use some form of propelling instrument so constructed as to act upon the air surrounding the body or flying machine, and thus furnish the propelling force.

Before, however, discussing propellers, it is desirable to point out that the form and shape of the flying machine may, if badly designed, have a very injurious effect on the propelling instrument. For example, a marine ship with a square stern almost always gives unsatisfactory results, because the screw blades work in disturbed water, and the full value of the propeller thrust is not obtained. In air ships, it is to be hoped, defective forms will be avoided, and the propellers so placed that they will work in undisturbed air, which is much the most satisfactory plan. The loss of power by a badly-formed ship can only be found experimentally.

As regards the propellers themselves, there are three which are usually considered, viz., the jet, paddle, and screw, and they all act upon the same principle, viz., a certain mass of air, water, etc., is driven astern per second of time with a certain velocity, and the thrust or driving force = mass × velocity (Rankine's rule).

The jet and paddle propellers are not suited for aerial work, because the first requires a very large amount of material to work it, while the second is very unwieldy and awkward to construct and operate.

The screw propeller can be made in two forms, the wing type, viz., that used by the birds, and the rotary type, used in marine propulsion.

As regards the wing type, it is very difficult to say whether it is more efficient than the marine type because wings are used to support as well as to propel, but this class has one objection which seems to be fatal to its use in flying machines, viz., that should the actuating apparatus of the wings get out of order, disaster is almost certain to occur, owing to the alteration of the form of the wings, which it must be recollected have *to support* as well as drive the body.

Probably, therefore, the well-known marine type of screw-propeller will be found the most satisfactory for aerial work, as, if it is broken or damaged, the safety of the air ship will not be affected.

As regards the marine type, it is not intended here to describe its action, but one point may be noticed, which does not seem to have been considered hitherto. The blades are, so to speak, flying surfaces required to move with a certain speed over a fixed path; and consequently if, by testing the blades as described for surfaces, in a still or open air apparatus as explained above, we find the power required to drive them, the line of action of the air force, etc., it would seem to be comparatively easy to find with very fair accuracy the power required to work the propeller.

In marine engineering great difficulty has always been found in estimating the power of propellers, because Rankine's rule, given above, is extremely difficult to apply. It is impossible to find out how much water is driven astern or what the velocity of the water really is; consequently no satisfactory results can be obtained by calculation. But with the air propeller, matters will be much easier, as there is no difficulty about testing the blades, and a very good estimate of the driving power required for any given propeller can then be got.

(8) Fuel.

In order to provide the "Driving Force" fuel or material, capable of giving out heat (or in other words, work), is necessary. Such fuel must be safe, have a good heat capacity, and be convenient to handle.

The fuels in common use are: coal in its various forms, oil, explosives, and materials for making electricity.

Coal in its solid form is the commonest kind of fuel; it is safe, and has a fair heat capacity (12,000 B.T.U.), but, on the other hand, it is awkward to handle and stow, and its heat

capacity is a good deal less than that of petroleum oil.

The gaseous form of coal gives very good working results in suitable engines, but it has one great objection, viz., that it must be compressed for stowage, and this consequently quite unfits it for use in flying machines.

Coal dust, or some of the patent fuels seem to be very promising forms of fuel, as they have most of the advantages of coal, and are much more convenient to handle and store (see Diesel engine).

Next, as regards petroleum, there are three kinds which are generally used, but only one, the medium oil, with a specific gravity of ·8, flashing point 73° F., and heat capacity 20,000 B.T.U. per lb., appears to be really safe for aeronautical work. This kind of oil is used a great deal in oil engines, and gives very satisfactory results; the only objection to it for war being its liability to catch fire if struck by an exploding shell.

Explosives have always been a very favourite form of fuel with inventors. Unfortunately, however, they have great disadvantages; in the first place, there is always a risk in handling them; and in the second place they are not nearly so efficient from the heat (and consequently power) point of view as is popularly imagined. A pound of coal and a pound of gunpowder, *when supplied with oxygen necessary for combustion*, give out about the same quantity of heat (or power). But in the case of the gunpowder the oxygen forms part of the powder, while with the coal the oxygen is obtained from the air, free gratis, so to speak, and consequently with the latter there is a saving in weight, owing to no oxygen having to be carried. Hence, until some alteration can be made in the condition of explosives, it seems unlikely that they will be useful for working motors.

As regards electricity, there is no doubt that the materials used at present are far too heavy in proportion to their capacity for work to be of any use for aeronautical work. Some good results have been obtained on a small scale with coal by Borchers and others, but nothing really satisfactory for general work is obtainable at present.

(9) Motors.

As explained above, the fuel supplies the power required for propulsion; the motor is a machine devised to utilise the power to the best possible advantage. It cannot be said that at present there are any very good motors in existence; the best of them does not utilize 30 per cent. of the heat of the fuel, and the remaining 70 per cent. is not only lost, but is chiefly expended in more or less damaging the motor itself. Moreover, with the present system of working there does not seem much possibility of any really satisfactory improvement, as the waste of power is due to circumstances largely beyond our control. For instance, in a gas or oil engine, about 35 per cent. of the heat of the fuel is wasted in the exhaust, and this cannot well be much reduced owing to the difficulty of reducing the exhaust temperature below the ordinary temperature of the air. Again, the loss of heat to the water jacket of a gas engine can only be improved by using a very much higher piston speed, an arrangement which is, practically, speaking impossible, on account of the mechanical difficulties in constructing pistons and cylinders capable of bearing such largely increased strains. Taking, however, the principal well-known motors, the following may be considered as more or less suitable for aeronautical work. Steam or vapour engines, gas and oil engines, electrical motors and a new form of engine called the "Diesel," which works on an entirely novel principle.

Steam and Vapour Engines.—The ordinary marine type of steam engine gives fairly good results, about 1¼ lbs. of coal being required per hour for one H.P.; the weight of the motor is, however, very great, viz., from about 200 lbs. per H.P. for ordinary steamers to about 60 to 40 lbs. for torpedo boats, yachts, ets. The Maxim engine, in which petroleum was used for firing and as working fluid, weighed only about 10 lbs. per H.P., all told, which was marvellously little; while the expenditure of fuel was only about .8 lb. petroleum per H.P. per hour. A promising form of rotary engine, designed by Parsons, has, it is understood, given good results in the steamer "Turbinia," but the designer has not yet published his trials.

Gas and Oil Engines.—Up to the present a gas engine seems to hold the record for efficiency, as one quoted by Clerk (see "Proceedings of Institution, C.E., 1896), had an efficiency of 27.5. But the difficulty of stowing the gas will always be against this kind of engine, and it is not likely to be used for aeronautical work.

The oil engines, on the other hand, promise well; they are very nearly as efficient, and some of them, like the Kane-Pennington, are very light.

The Kane-Pennington appears to be a very good motor of its class, as it is powerful, light, and does not require a water jacket. This latter is a matter of the highest importance, as the ordinary gas or oil engine requires a very large amount of cooling water, and the re-cooling of this water, after it has left the water-jacket, is one of the great difficulties in connection with this type of engine. No doubt the water can be cooled by passing it through the tubes forming the framework of the flying machine, and taking off some of the heat for warming purposes, but any engine which can work without a water-jacket will most undoubtedly be far more convenient for aerial work.

Another good motor is the Loyal, which also works without a water jacket, and seems to

be extraordinarily economical, its efficiency being apparently about 40 per cent. But in this case, as with the Kane-Pennington motor, accurate trials and experiments are much required to give the exact amounts of power generated.

Electrical Motors.—The electrical motor is the ideal one for aeronautical work, but the methods of generating electricity are not at all satisfactory at present. If a dynamo and steam motor is used, it is obvious that the final efficiency will be less than that of the steam engine, so that this form of motor is quite out of the question.

The battery form, whether primary or secondary, is also unsuitable, on account of the very great weight of the materials required, and it cannot be said at present that there is any reasonable chance of a good electrical motor being found for aeronautical work.

The Diesel Engine.—A new form of engine is at present being worked out by the inventor, Herr Diesel, the peculiarity of which is that its system of work is quite different to that employed in any existing engine. According to Herr Diesel, all heat engines at present in use work on a wrong principle, because they supply too much heat to the working fluid, and supply it at the wrong time.

According to his theory, the following are the fundamental conditions for the successful working of any heat engine:—

1st. The highest temperature of combustion should be produced by highly compressing the working fluid (air).

2nd. The combustible coal, oil, etc., should be introduced into the mass of highly compressed and heated air during part of the return stroke of the piston; no increase of temperature taking place. After ignition, combustion should not be left to itself, but arranged so as to maintain the right proportion between the pressures, volumes, and temperatures.

3rd. The proper proportion of air and combustible should be used so as to limit the maximum compression temperature, and thus enable the engine to work without a water jacket. The experimental engine now being tested works between the limits 800° C. and 130° C., and the inventor hopes to get an efficiency of about 60 per cent. (see the *Rational Heat Motor*, by R. Diesel, translated into English by B. Donkin).

Before leaving the subject of motors, it is desirable to touch on two important points, viz., "the efficiency of engines," and "the weight of engines per H.P.," terms often used in a very casual manner.

By the efficiency of an engine is meant

$$= \frac{\text{useful work}}{\text{total work}}$$

$$= \frac{\text{heat usefully expended}}{\text{total heat the fuel is capable of giving out,}}$$

and no other definition accurately expresses the true efficiency.

By weight of an engine per H.P. is meant

$$= \frac{\left\{\begin{array}{l}\text{The total weight of boiler,}\\ \text{engine, dynamo, con-}\\ \text{densers, etc.,}\end{array}\right\} + \begin{array}{l}\text{Total weight}\\ \text{of fuel for } x\\ \text{hours}\end{array}}{\text{the number of effective or break H.P.}}$$

No standard for x has ever been laid down, but for aeronautical purposes it would be convenient to have some such standard, say, as follows:—

A Standard	... ...	$x = 10$ hours.
B Standard	... ...	$x = 30$ hours.
C Standard	... ...	$x = 50$ hours.

(10) Materials for Construction.

The materials likely to be used for the construction of flying machines are:—Steel, wood, aluminium, silk, canvas, etc.

Steel will be found useful for framework, engines, etc. Tube steel, similar to that used for bicycles and horseless carriage framework, will form the basis of the machine, while steel wire rope should be employed for guys, etc. The engines will also be largely made of steel.

Aluminium is not as strong as steel for its weight, but for parts where no great strain is likely to come may be found useful.

Silk, Canvas, etc., will be required for the surfaces of aeroplanes such as Maxim's, but possibly some form of aluminium wire woven webbing may be found preferable if the cost can be got to within reasonable limits.

Wood.—With the Phillips and Lilienthal types of machine, wood is largely used; in the former for the supporting slats, in the latter for the framework.

Passing now to

(11) The Design of Flying Machines,

the following general notes may be found useful:—

Type.—There are at present three types of machine which seems likely to prove successful, and to distinguish them they will be called after their inventors, viz., the Lilienthal (soaring only), the Maxim, and the Phillips. Numerous pictures of these machines have appeared in the public press of late years, and their general form and construction is well known to aeronauts.

The Lilienthal machine is for "soaring" only, and does not call for much remark, as this kind of flight can never be used for, say, fast passenger traffic, or war purposes.

The Maxim machine consisted of a large kite-like surface, underneath which was hung

a suitable car for carrying passengers, motor, stores, etc. To start, the machine was driven along the ground at a high speed, and on a certain velocity being reached, the air pressure under the aeroplane or surface raised the machine in the air. The machine did rise a little on one occasion, but an accident (which had nothing to do with the aeronautical part of the test) occurred, and prevented further trials.

The Phillips machine has no large sustaining surface, but a number of small ones, and appears to be specially suited for war purposes, as if painted a light grey, or lead colour, it would be, practically speaking, invisible at about 1,000 yards range.

Weights to be Carried.—These are the passengers, war material, stores, etc. It is not possible to lay down any proportion between them at present, but for a small experimental machine the following might be tried:—Passenger, 150 lbs.; machine framework, etc., 120 lbs.; motor and fuel for one hour 80 lbs.; or a total of, say, 350 lbs. to 400 lbs.

Ratio of Sustaining Surface to Weight.—In birds this varies from ½ lb. per square foot to about 2 lbs., probably in this case 1 lb. or 1½ lbs. per square foot would be sufficient.

Dimensions.—These will depend upon the resistances, and power required for driving. Probably, a platform 8 feet by 3 feet will be suitable for the body; it should hang some 8 feet to 10 feet below the sustainer. The latter might have a surface of about 300 square feet, or rather more; this would enable the machine to leave the ground when its velocity = about 20 to 25 miles per hour. A well designed curved surface might, however, be only about 200 square feet in area, and this would be a great advantage.

Power.—By means of models and a whirling table, a very good idea of the power required could be obtained. Probably from 6 to 8 h.p. would suffice in this case.

Detailed Design.—The approximate design having been worked out, the detailed design should now be taken in hand and drawings made of all the different parts, such as framework, sustainer, propellers, etc. An accurate model, exactly to scale in weight as well as dimensions, will be found very useful.

Motor.—The most convenient fuel will be petroleum oil or coal dust. The Diesel type of engine, or Kane-Pennington type, seem to be the most suitable kinds of motor.

Starting and Landing Apparatus.—Light wheels of the bicycle type, but smaller, will possibly be best for this. For a small machine rails, as used by Maxim, are unnecessary. All that is required is a large, smooth, open space where starting and alighting can be conveniently carried out.

Steering Apparatus.—In the horizontal plane a vertical rudder can be used, or one screw propeller run faster than the other. For the vertical plane, fore and aft rudders connected together, so that they can be worked simultaneously from the platform, will be found convenient. The effect of these rudders should be tested by models.

Testing.—This should be done with great care; a calm day being selected for the preliminary tests. The machine should be run along the ground, the fore and aft rudders being so adjusted as to make it rise with the platform (or car) horizontal.

Flights.—A few feet above the ground will be quite sufficient for trial flights, the object being to see how the air affects the machine.

The above remarks only explain generally how the designing and testing of a machine might be carried out; precise methods depend upon the machine. The principal points to attend to are:—

1st. Have a large, smooth, open place to practise in.

2nd. Make quite certain of the "balance" or "stability" of the machine before trying experiments at high speed.

(12) The Flying Machine in Peace.

The principal use of the flying machine in time of peace will be for special commercial work, scientific exploration and amusement. As regards commercial work, fast mail and passenger traffic seem to be the most suitable applications, because high speed can be obtained, and the cost of transit will be comparatively cheap. A very fast machine of the Maxim or Phillips type should be built for £5,000, and probably less; while the cost of wages, fuel, etc., will be small. Landing places, species of "land harbours," will of course be required, but the great advantage over railways will be the saving in the purchase of land for permanent way purposes, and the up-keep of the latter.

As regards scientific exploration, there is no doubt that flying machines will be most useful for geographical work, and also for the exploration of the upper atmosphere.

It is to be hoped, also that, as an amusement, aerial yachting will find followers just as marine yachting does at present.

(13) The Flying Machine in War.

The chief use, however, of the flying machine will be for war purposes, and in the near future an "Aerial Force," like the present "Sea" and "Land" Forces, will be a necessity for all nations.

Future wars will commence with heavy

fighting in the air between the opposing aerial navies, followed by attacks on marine fleets, and concentrated bodies of troops by the conqueror. Marine navies will specially suffer, and among the land forces cavalry, artillery, and all mounted troops will find anything like concentrated action an impossibility.

To sum up:—

1st. In the near future, aerial warfare by swift flying air-ships will revolutionize the present methods of war by sea and land.

2nd. Owing to the high rate of speed of the air-ships, all nations will have to maintain themselves ready for war *at very short notice.*

3rd. The nations most affected by aerial warfare will be those which depend at present for their defence on marine navies.

4th. As aerial ships will be, comparatively speaking, inexpensive, the smaller nations will be able to make use of them.

5th. Owing to the possibility of war at very short notice, a larger proportion of a nation will have to be kept under arms.

6th. Warfare by sea and land, on any extended scale, will only be possible to the nation which has the command of the air.

J. D. FULLERTON, *Major, R.E.*
The Brine Baths Hotel,
Nantwich, Cheshire.

Langley's Flying Machine.

Full accounts have now been published of the interesting experiments conducted by Professor S. P. Langley with his model "Aerodrome." Both the "Strand Magazine" and "McClure's Magazine" give almost identical accounts from the pen of the inventor, while in the "Aeronautical Annual," a somewhat more technical description is given.

These accounts go to show that which is so well understood by many of our readers, the extreme difficulty in the designing and constructing of such an apparatus. His well-known experiments with a whirling table gave the inventor valuable data to work upon, but the question of balance and behaviour in the air had to be studied, and this could hardly be done without constructing a complete working model, yet how could such a model be made until the principal conditions of flight were learned? So it seemed that the inventor was "shut up in a sort of vicious circle."

Having constructed over 30 modifications of rubber-driven models, however, a model was constructed to be propelled by a steam engine, but after many months' work it was found that the weight could not be reduced below forty pounds, while the engine would only develop half a horse power, and finally the model was condemned. A second apparatus, to be worked by compressed air was then tried, but the power proved insufficient. Then came another with carbonic acid gas engines. Then others with various applications of electricity and gas, etc., but the steam engine was found most suitable, yet "it seemed to become more and more doubtful whether it could ever be made sufficiently light, and whether the desired end could be reached at all. The chief obstacle proved to be not with the engines, which were made surprisingly light after sufficient experiment. The great difficulty was to make a boiler of almost no weight which would give steam enough."

At last a more or less satisfactory engine was constructed, but then other difficulties cropped up. To prevent the machine smashing itself against the ground when anything went wrong, it was found best to test it over water. And in order to start it against the wind a kind of house-boat was procured, so that the starting apparatus could be directed to any desired point. But then came the difficulty of giving the apparatus an initial speed, which was deemed necessary to start it.

It was in 1893 that these first trials of the "Aerodrome," launched from the house-boat, were made, but yet the difficulties, the constant failures, the inefficiency of the apparatus were such that three years more of constant work had to be devoted to the machine before a really successful flight had been made.

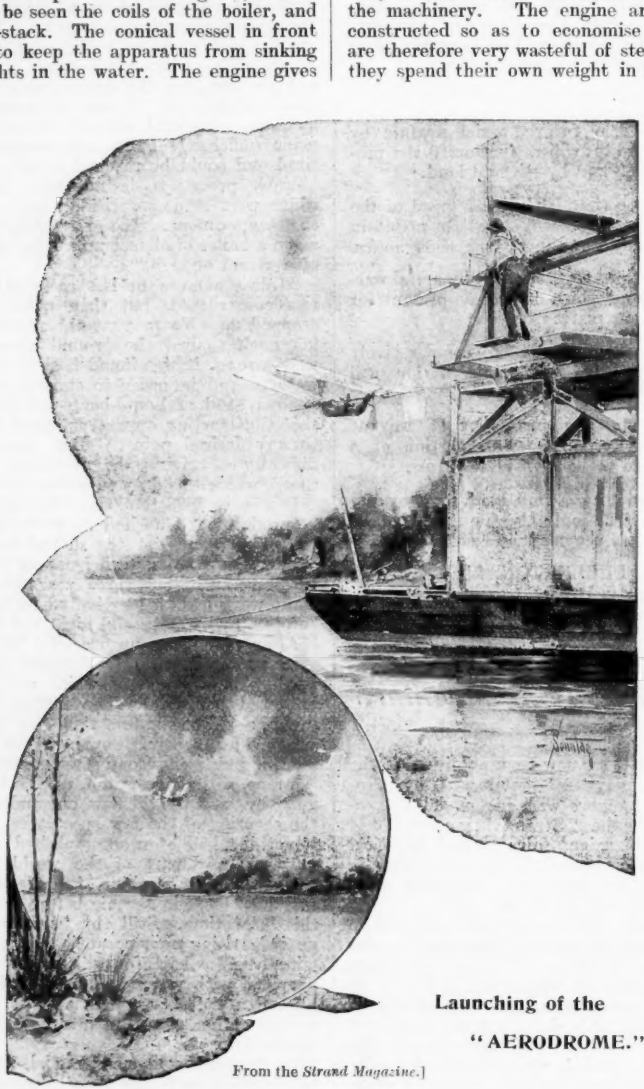
After very many unsuccessful trials, a good start was made with No. 5 model on May 6th, 1896, a photograph of which was taken (reproduced herewith). The inventor describes it thus:—"For the first time the 'Aerodrome' swept continuously through the air like a living thing, and as second after second passed on the face of the stop-watch, until a minute had gone by, and it still flew on, and as I heard the cheering of the few spectators, I felt that something had been accomplished at last, for never in any part of the world, or in any period, had any machine of man's construction sustained itself in the air before for even half this brief time. Still the 'Aerodrome' went on in a rising course, until, at the end of a minute and a half (for which time only it was provided with water and fuel), it had accomplished a little over half a mile, and now it settled rather than fell into the river with a gentle descent."

In November another model, No. 6, was tried, which went for about three-quarters of a mile at a rate of about 30 miles an hour.

The latest model, as may be seen in our illustration, consists of two pairs of rigid and motionless wings, each slightly curved, attached to a long steel rod, from which depends the body of the machine in which are the boilers, engines, and machinery. Two screw propellers between 3 and 4 ft. in diameter, are placed in rear of the front pair of

wings, on each side of the central rod. The front portion of the hull is closed by a sheathing of metal to protect the fire-grate, behind which may be seen the coils of the boiler, and the smoke-stack. The conical vessel in front is a float to keep the apparatus from sinking when it lights in the water. The engine gives a force of 1 to 1½ h.p. The boiler, with its fire-grate, weighs a little over 5 pounds, and the engine, with all its moving parts, but 26 ounces. The propellers revolve at rates varying from 800 to 1000 turns a minute. The rudder, adapted both for vertical and horizontal steering, is placed in rear of all.

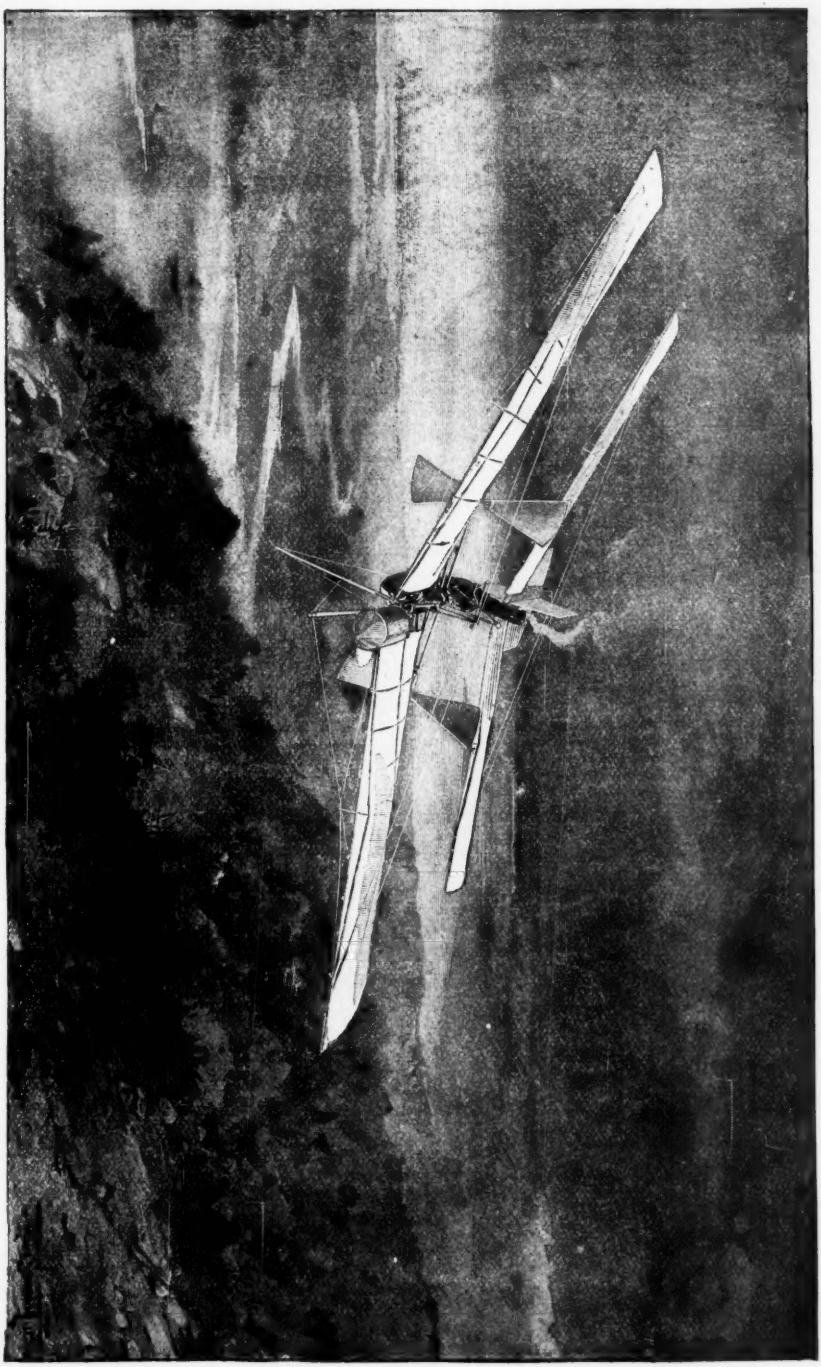
The width of the wings from tip to tip is between 12 and 13 ft., and the length of the whole about 16 ft. The weight is nearly 30 lbs., of which about one-fourth is contained in the machinery. The engine and boiler are constructed so as to economise weight, and are therefore very wasteful of steam, of which they spend their own weight in five minutes.



Launching of the "AERODROME."

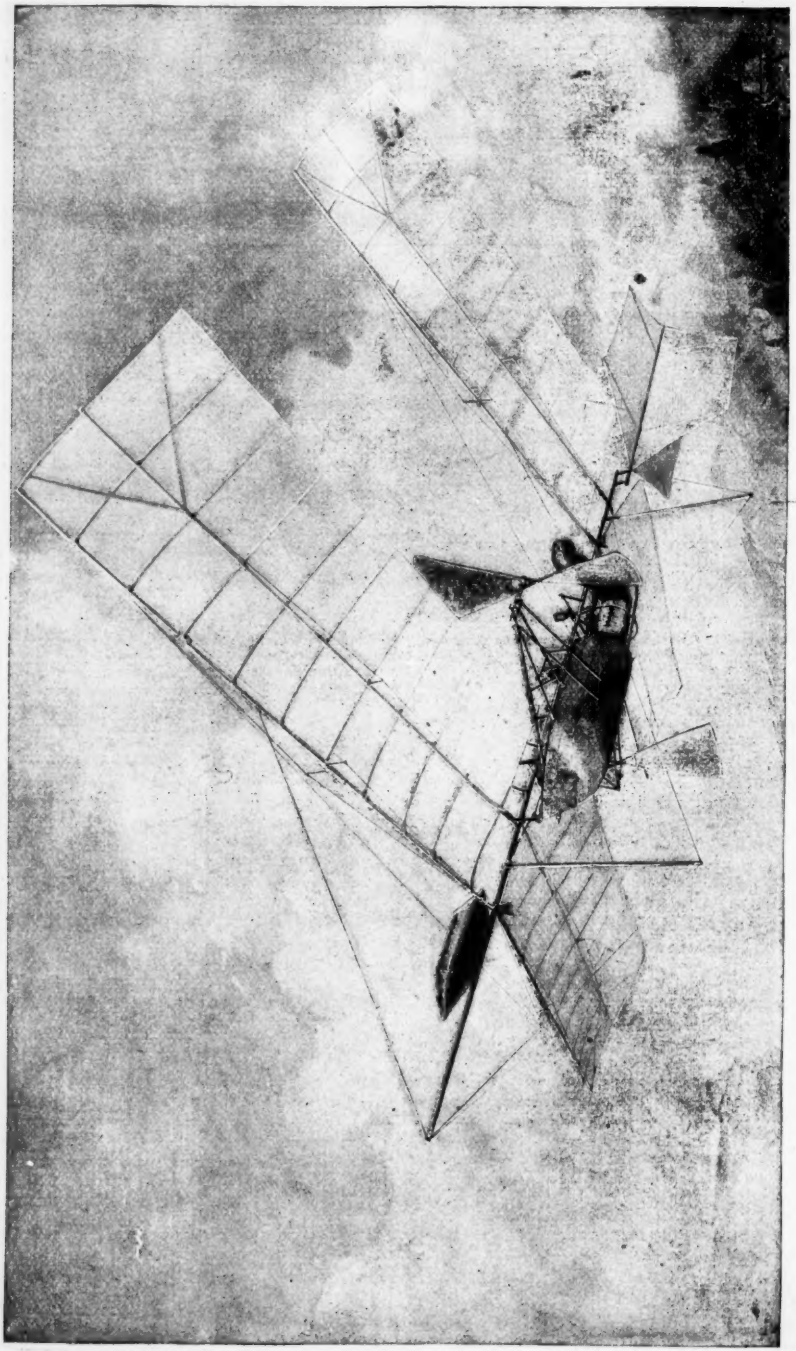
From the *Strand Magazine*.]

Condensers cannot easily be introduced in so small a scale of construction. The length of flight of this model is therefore very limited, though, if necessary, it could doubtless be greatly prolonged without much difficulty. There are two cylinders, each with a diameter of 1¼ inches. The piston stroke is 2 inches. The two screws, with a pitch of 1¼, are 39



From the *Strand Magazine*.]

THE "AERODROME."



THE "AERODROME."

From the *Strand Magazine*.]

inches from tip to tip, and revolve in opposite directions.

The boiler consists of a continuous helix of copper tubing, $\frac{3}{8}$ inch external diameter, the diameter of the coil being 3 inches altogether. Through the centre of this is driven the blast from an "Ælopile," a modification of the naphtha blow-torch used by plumbers, the flame of which is about 2000 F. The pressure of steam issuing into the engines varies from 100 to 150 pounds per square inch. Four pounds of water and about 10 ounces of naphtha are carried. The boiler evaporates about one pound of water per minute.

How to Advance the Science of Aeronautics.

By V. E. Johnson, M.A.

On commencing the study of aeronautics it is above all things most important that we should make ourselves thoroughly acquainted with what has already been accomplished in order to save waste of effort on our part in trying experiments or devices already dealt with. Again, it is quite a mistake to suppose that but little, if anything at all, has as yet been accomplished towards the solution of this—the, perhaps, greatest of all mechanical problems. We do possess at last a *science* of aeronautics, and a preliminary study of this same science is a *sine quâ non*; the successes and failures of the past must be carefully studied, as also the apparent causes of such successes and failures; and the principles involved—that is to say, the aerodynamical principles—must be above all things, most carefully studied, in order that the investigator may be perfectly enabled to distinguish between any inadequate proposal, certain to fail, and a design worthy of consideration, investigation, and, perhaps (after careful thought), a practical trial.

I give therefore, at the end of this article, a list of books, articles, etc., the study of which will make any student of this science quite *au fait* with what has already been accomplished in this subject. The subject—so far as concerns any practical issues, is as yet beyond the scope of mathematical analysis; and, taking into account, the extreme complexity of all atmospherical movements on any practical scale, I venture to say will long continue to be so. Recourse must always be had to experiment and common-sense, which Guizot defined as "the genius of humanity." But they must be experiments conducted on correct scientific lines; mere hap-hazard experiments are useless, if nothing worse. A preliminary scientific training—more particularly on the experimental side—is obviously most useful; and a good sound knowledge of elementary mathematics and mechanics has now become in reality a necessity.

There is no longer any *mystery*, strictly speaking, attached to aeronautics. Even that great stumbling-block to early observers—the sailing and soaring flight of certain birds—has been reduced to perfectly intelligible mechanical laws. It is now possible to construct a motor of such a horse-power and yet possessing such lightness that it is able—by the attachment of suitable apparatus—to sustain itself in a calm atmosphere; to launch itself into the air by means of special appliances, and to alight with safety on some specially prepared or chosen surface.

This, however, is not by any means the complete solution of the problem which requires a machine that will arise or alight vertically (or practically so) in wind or storm, and maintain its equilibrium in the atmosphere under other conditions than the "calm of evening." To elevate a flying machine into the air is one thing; to maintain its equilibrium there under adverse circumstances, is something very different. Electrical and other motors (but the former are preferable in this case) can now be built of such lightness—neglecting, in the case of electricity, the source of electrical energy—that they can, by means of suitable appliances, elevate and maintain themselves in the atmosphere. Much, I think, might be learnt from the behaviour of such, in the form of large models attached to a central axis of rotation, round which they might fly, and through which the electrical energy might be conveyed by means of suitable wires, etc; more especially their behaviour in stormy weather. Kinematographic representations of the same would be invaluable for future reference. Indeed, the kinematograph might be made, in my opinion, to play a by no means unimportant part in the advancement of aeronautics. These models must, however, be of large dimensions for really useful practical data, their aeroplanes being fifteen or twenty feet across at the very least. Any invention which will supply us *per se* with a motor developing more horse-power per pound weight than any yet created will advance this science. Any discovery which will give us a material or substance possessing more strength per unit of weight will do the same; as also will an aeroplane of such a shape as to lift more weight per square foot of surface than any such as yet constructed when travelling through the atmosphere at the same angle of inclination to the horizontal and at the same speed. The same remarks hold true *mutatis mutandis* with respect to aerial screws.

It is obvious that the general configuration of the air ship should be such that it shall move through the air with the minimum of resistance (both lengthways and sideways) *at the speed at which it is intended to drive it.* Experiment in this direction may therefore be not entirely without value.

The following brief list contains, to the best of the writer's knowledge, some of the most important writings that have been published on this subject during recent years.

"Aerial Navigation," Maxim.—"Century Illustrated Monthly." October, 1891.

"Aerial Navigation," Holland.—"Cosmopolitan." November, 1892.

"The Aeroplane," Maxim.— "Cosmopolitan." June, 1892.

"Progress in Aerial Navigation," Maxim.—"Fortnightly Review." October, 1892.

"Experiments in Aerodynamics," Langley.—"Smithsonian Contributions to Knowledge," Washington, 1891. (A brief account by Rayleigh in "Nature," December 3, 1891.)

"The Internal Work of the Wind," Langley.—"Philosophical Magazine." May, 1894.

"Phillip's Aerial Machine."—"The Times." May 24th, 1893.

"Professor Langley's Flying Machine."—"English Mechanic." May 12th, 1893.

"Flying Machine Motors and Cellular Kites," Hargrave.—"English Mechanic." November 3rd, 1893.

"Mr. Maxim's Flying Machine."—"The Times," August 3, 1894.

"Aeronautics." (A journal published during 1894. Forney, 47, Cedar Street New York.)—Contains a full account of the proceedings of the Conference on Aerial Navigation, held in Chicago, August 1, 2, 3, 4, 1893. It is without doubt a very valuable publication on the subject.

"Aeronautics," Brewer and Alexander.—(London: Taylor and Sons, Red Lion Court, Fleet Street 1893.)—Contains an abridgement of Aeronautical Specifications filed at the Patent Office from 1815 to 1891. It consists of much that is instractive, not a little that is absurd, and sometimes ideas that are even sad.

"Copies of Mr. Maxim's Patent Specifications," Nos. 16,883, A.D. 1889; 19,228, A.D. 1891; 19,254, A.D. 1892; and 10,852, A.D. 1893, should be obtained from the Patent Office and be carefully studied.

"Progress in Flying Machines," by O. Chanute.—Published by the "American Engineer and Railroad Journal," 47, Cedar Street, New York, and which contains an account of the best work done on the subject up to 1894, together with some able criticisms on the same. Is by far the best and most complete book that I know of on the subject, and should be in the hands of all aeronautical students.

The foregoing list can be supplemented by the one given on page 16 of the new "Aeronautical Journal," to which may be added "Nature," January 30th, 1896. Lilienthal's Experiments on Flying (Illus.).

The Fatal Accident to Dr. Wölfert's Balloon.

It is with extreme regret that we have to chronicle yet another fatality to experimentalists in aerial navigation. Not only do we lament our loss of the lives of two valued confrères, but deplore the failure of the experiment, the calamity which must act so detrimentally to the cause we have in view.

Dr. Wölfert, a man of forty-five years, had for many years devoted himself to the construction of a navigable balloon. In 1884 he made two trials with a cigar-shaped balloon of about 18,000 c. ft., the car of which was rigidly attached to the gas bag. Two screws were worked by man power, and though a deviation from the wind course was gained, no great speed was, of course, attained. He then proposed adding a 5 h.p. motor. Later on he constructed another and larger balloon, which was exhibited at the Berlin Industrial Exhibition last year, and which is the one to which this appalling accident has happened. An illustration and description of this machine appeared in our number for January last. But it had undergone many improvements, including the addition of an aluminium screw, and a benzine motor of 8 h.p. The balloon was about 240 ft. long and 90 ft. diameter.

On June 12th, the apparatus was to undergo trials at the grounds of the Military Balloon Department, in the Tempelhofer Field, near Berlin, where a number of people were assembled to watch the experiment. Dr. Wölfert himself and a mechanic named Knabe got into the car.

The balloon ascended to a height estimated at 2,600 feet, and was steadily progressing against the wind, when something appeared to be wrong. The machine lurched from side to side; a loud report was heard, and then flames shot out, and the balloon became ignited. The car becoming detached fell rapidly to the ground.

The frightfully mutilated and charred remains of the two unfortunate aeronauts fell into a neighbouring timber-yard. It was evident that death had closely followed the fiery explosion.

It is supposed that the cause of this disaster was owing to the aeronaut omitting to turn off the flame before opening the lower valve of the balloon, which was situated immediately above the motor, though the report heard would rather point to its being due to an actual explosion of the benzine engine. On the other hand, it had been noticed before the balloon left the ground that the flame of the benzine motor on several occasions shot out to a considerable height, and apprehension was expressed as to the safety of the venture.

Hargrave's Motor & Propeller.

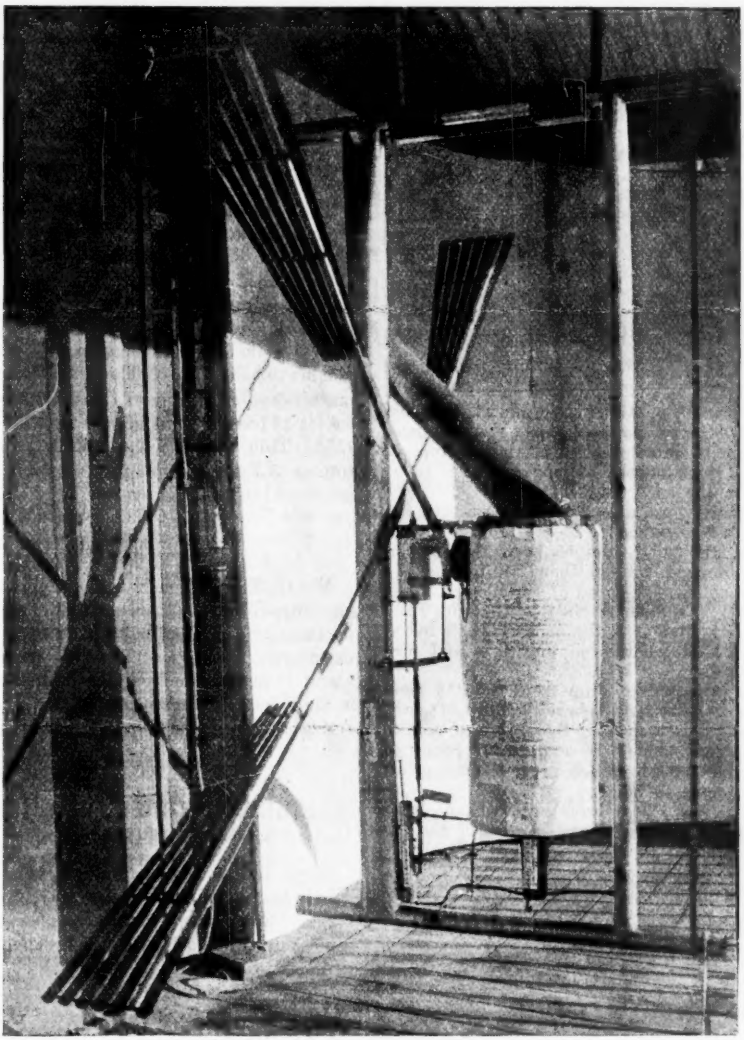
The illustration shows Mr. Hargrave's latest device of a motor for a flying machine (February, 1897). The engine appears to work well, the "fire being very steady" and "the boiler supplies plenty of dry steam." The propellers, moved up and down with a feathering action, "produce a steady thrust in the line of the wing axes," but, as yet, the amount of thrust obtained is not satisfactory.

The boiler consists of 124 ft. 6 ins. of 5-16 in. copper pipe; outside surface, 10.27 sq. ft.; content, 88.4 c. in.; weight of pipe, 8.37 lbs.; coiled, 8½ ins. outside diameter; upper 2-3rds of pipe branches into 2 parts, joining again at the steam-pipe.

The weight of the motor complete (without water or kerosene), 33½ lbs. The retort is made of 7 ft. 6 in. of ¼-in. copper pipe.

The kerosene fuel is stored in the long upright tube on the right of the picture, the water in the larger tube to the left.

The engine cylinder is 2½ in. diameter, and 5 in. stroke. An air or kerosene pump is placed at the lower left hand.



HARGRAVE'S MOTOR.

Andrée's Polar Balloon.

It is possible that the bold aeronaut, M. Andrée, may at this moment be hovering in mid air over the Pole, for he arrived at Spitzbergen on May 30th, firmly resolved to again attempt the journey in his balloon. The balloon house, though it had suffered greatly from the wintry storms, has been repaired, and the inflation of the balloon commenced on June 18th, so that it should be ready some five weeks earlier than last year.

Dr. Eckholm, who is said not to consider the balloon sufficiently strong or capacious for its work, has not accompanied the expedition, so that the voyagers will consist of MM. Andrée, Strindberg, and Fränkel, while Lieut. Swedenborg has accompanied them in order to go in the balloon should it be possible or desirable.

The arrangements are practically the same as last year, but the balloon has been increased in capacity by 300 c. metres by the insertion of an equatorial band, so that it is now about 140,000 c. feet, with a lifting power of over 9,000 lbs.

The loss of gas during the period it was inflated last year gas found to be about 2,000 c. feet a day. But M. Andrée allows for a loss of 3,000 c. feet, under which circumstances the balloon could remain in the air for six weeks. Four months' supply of food is to be taken in the car.

The drag ropes are calculated to retard the speed to the extent of 25 per cent. less than that of the wind, and to keep the balloon at an average height of about 840 ft.

With an average speed of 16 miles an hour, the Pole should be reached in 42 hours from the start. But it is the journey back to inhabited lands that is so uncertain and problematical.

It is proposed to drop from time to time messages enclosed in spherical buoys of cork, with a flag attached. By this means it is hoped that should the expedition come to grief, some record of their progress may, at all events, come to hand.

Special stores have been sent to Franz Josef Land by the "Windward" in case of the explorers finding themselves in that neighbourhood.

Believing as we do that through the air is the only sure road to the Pole, we wish the gallant voyagers all success and a safe return!

NOTES.

COUNT ZEPPELIN'S BALLOON.

The *Financial News* announces that "An interesting company is being formed at Stuttgart, under the title of the Gesellschaft zur Forderung der Luft-Schiffahrt. With a capital of 1,000,000 marks, this company will endeavour to realise the prospect of governable aerostation in conformity with the plans of Count Zeppelin. Large blocks of shares are stated to have been applied for by serious persons who believe in the future of the company." It may be added that the Count, who is a German cavalry officer, has for years been studying the question of navigable balloons, and has several times brought forward his proposals.

THE "TURBINIA'S" LIGHT ENGINES.

This experimental launch, fitted with a steam-turbine engine designed by the Hon. C. Parsons, has lately beaten all records by travelling at a speed of 34 knots an hour. According to *Nature*, "the weights are remarkable, and certainly have never before been equalled for lightness in any practical marine machinery." The total weight of machinery, boiler, screws and shafting, tanks, &c., is 22 tons, and the horse power developed 1576. This would give 71 horse power per ton, or 31 lbs. per horse power.

BOOMERANGS.

Mr. G. T. Walker has communicated to the Royal Society (March 15th), some Notes on this curious aerial toy. In the specimen described, the "arms" are twisted through about 4° in the same manner as the blades of a right-handed screw propeller. The theoretical action is discussed.

FIRING SHELLS TO HIGH ALTITUDES.

Some interesting experiments have recently been conducted at the Lydd Artillery Camp. Some heavy guns were placed in an almost upright position, and the shells were projected to a height of 3,600 ft.

ACCIDENT IN A BALLOON.

During the Yorkshire Gala, Mr. Percival Spencer made a balloon ascent, accompanied by five gentlemen. On descending, near Driffield, the car bumped heavily on the

ground, with the result that one of the passengers, Mr. G. C. Lee, broke his leg, though how the accident happened exactly cannot be explained.

KITES FOR METEOROLOGICAL INVESTIGATIONS.

A paper by Mr. A. L. Rotch, of the Blue Hill Observatory, Mass., was read before the Royal Meteorological Society on April 21st, describing the experiments conducted at that Institution with Kites. *Nature* (June 24th) says :

"The United States Weather Bureau has been conducting experiments with kites flown at distances of from one to two miles above the earth, and now it is claimed that it is possible to forecast the weather for a period of sixteen hours longer than at present, and more accurately. It is said that the fact has been established, that shifting of the wind occurs at the height of a mile above the earth's surface from twelve to sixteen hours before the same change of direction occurs on the surface. Researches by means of high-flown kites and aeroplanes have now been prosecuted so far as to warrant the expectation that, within six months, the United States Weather Bureau will be able to construct a telegraphic synchronous chart, based on conditions of the atmosphere, one mile above the earth. This chart will cover the region between the Rockies and the Alleghanies at the outset."

SPEED OF FLYING GEESE.

Some more observations have been made by Mr. H. Helm Clayton, at the Blue Hill Observatory, determining accurately the height and velocity of the flight of a flock of geese migrating northward. So rapid is the velocity of flight that the flock was visible to the observers (who were engaged in measuring cloud velocities with theodolites) only about two minutes ; but, during that time, two sets of measurements were taken. The calculations gave the height as 905 ft. above the ground, and the velocity of flight as 44·3 miles an hour. The direction of flight was from the S.W., the wind at the time being from W.N.W., with a velocity of 8 miles an hour.

PILCHER'S SOARING MACHINE.

Mr. Pilcher recently conducted some more trials with his apparatus at Eynsford. In this, the wing surface is about 23 ft. from tip to tip, spreading some 180 sq. ft. of area. A long rope was attached to the machine, which was hauled along so as to start it like a kite, and a very successful flight of about 150 yds was made.

BARNARD'S AIR-SHIP.

An ascent was made recently at Nashville, Tennessee, by Mr. A. W. Barnard, in a cylindrical balloon, 42 ft. long by 16 ft. diameter. A beam was suspended some 10 ft. below by netting, and to this was attached a saddle and pedals, like those of a bicycle, geared to a four-bladed screw propeller. The balloon was inflated with hydrogen, and rose to a height of 500 ft., and it is calculated that the aeronaut was able to drive it at a rate of 10 or 12 miles an hour across the wind, and was able to steer it round in a circle. A descent was made about 4 miles off. Some of the daily papers have commented upon this news with a tone of incredulity ; but, after all, there is nothing very remarkable in the achievement, though we might be inclined to think that the stated speed was somewhat exaggerated.

THE INTERNATIONAL BALLOON ASCENTS.

The following results were obtained by the simultaneous ascents on 13th May last.

Paris. Registering balloon "L'Aerophile I." went across the Alps and descended at Novara, having attained a height of 50,000 ft. "L'Aerophile II." descended at Dicy, height 22,000 ft. "L'Aerophile III." fell at Egreuil.

Berlin. Balloon with Dr. Berson ascended 20,000 ft. ; rough landing near Stolpe in Pomerania. Another balloon with Herr Siegsfeld and a register balloon also ascended.

Strasburg. Balloon with Dr. Hergesell and Lieut. Baron 9,100 ft., landed near Feldberges.

Register balloon "Langenburg" came down near Wolfach in Schwarzwald. Register balloon "Strassburg" attained an altitude of 32,500, descended after 13 hours in Fichtelgebirge.

St. Petersburg. Balloon "Wannowsky," height 9,000 ft., landed near Wiborg, Finland. Register balloon reached 36,000 ft.

Recent Publications.

"*The Aeronautical Annual*, 1897." Edited by J. Means (Boston, U.S.A.). London: W. Wesley & Son. 5s.

It is with much satisfaction that we welcome the third number of this very well-got-up annual, which this year is of especial interest.

Full accounts are given of Prof. Langley's latest experiments, an excellent portrait of the inventor forming the frontispiece. Some most interesting and profusely illustrated accounts are given by Mr. Chanute and by Mr. Herring of their experiments in gliding flight on the shores of Lake Michigan. It seems almost unnecessary for us to refer further to these experiments, since everyone interested in this subject ought certainly to obtain a copy of the annual and make a careful study of it.

We may just mention that from a number of machines experimented with, one with superposed and narrow aerocurves was found the most efficient, and that the best flight lasted for 14 seconds and covered a distance of 359 feet. A translation of Herr Müllenhoff's address on the death of Otto Lilienthal, embellished by a portrait of the unfortunate enthusiast, is followed by three papers by him, "Our Teachers in Sailing Flight," "At Rhinow," and "The Best Shape for Wings."

Mr. Chanute continues his most valuable contribution on "Sailing Flight," begun in the Aeronautical Annual No. 2. Mr. Huffaker writes on "The Way of an Eagle in the Air." Short articles by Mr. Maxim on "Screw Propellers Working in Air," and by Mr. Pilcher on "Gliding Experiments," are followed by a number of interesting notes under the head of "Miscellany" and several pithy articles headed "Editorial."

Altogether we can strongly recommend this book to our readers as one which is absolutely indispensable to anyone making a proper study of the question of aerial navigation.

"*On obtaining Meteorological Records in the Upper Air by means of Kites and Balloons*," by A. Lawrence Rotch, is published in pamphlet form by the American Academy of Arts and Sciences (Vol. XXXII., No. 13). The author begins by saying that "a knowledge of the physical conditions which prevail up to the highest cloud levels, five to nine miles above the earth, is of great importance to meteorologists," and points out that observations on mountains do not give what is required. Balloon ascents with observers are expensive and somewhat dangerous, while captive balloons are limited to lower altitudes and are blown down by wind, so that unmanned balloons and kites are alone suitable for the purpose. The Blue Hill experiments, of which we have given accounts, have proved the utility of the latter method up to 9,000 ft., and the "ballons sondes" recently sent up from Paris and from Berlin and elsewhere to heights up to 60,000 ft. have proved how satisfactorily the former method can be employed.

Foreign Aeronautical Periodicals.

L'Aéronaute (Paris) for April. "Second International Ascent of 'l'Aerophile'," "On the Apparatus Employed" and "Observations," written respectively by Messrs. Hermite and Besançon, L. Cailletet, and A. Muntz. Proceedings of the Société Française de Navigation Aérienne include memoir of M. Bretonnière and his observations on bird flight, and other matters. May, "On the Variation of the Electric State of the High Regions of the Atmosphere," by G. le Cadet. "On the Equation of the Aeroplane," by Vicomte Decazes. Proceedings of the Society, including a life of the late Mr. Brearey, experiments by M. Ricour, conducted in 1885, on the resistance of the air. Description of an apparatus for aerial propulsion by the reaction of the deflagration of mixed gases. A review of Capt. von Parseval's paper on kite balloons.

June. "On a Graphic Criterion Applic-

able to Flying Apparatus," by Capt. Marcotte. Announcement of the offer of two prizes of 1,000 francs each for a motor of 50 kilos. (1 cwt.) per horse-power, and for a study of the coefficients necessary for calculations for an aerial machine. Vicomte Decazis gives some calculations relative to aeroplanes.

L'Aérophile (Paris) for April-May. Life of Mr. Glaisher, with portrait, designating him "the grand old man" of aerial navigation. Observations of the seventh ascent of "L'Aerophile" Preparations for the Polar Expedition of M. Andrée. Military ballooning in Denmark (illustrated). "Theory of Dynamic Soaring," by Vicomte Decazes (continued). "Navigation Aérhydrique" (continued). Atmospheric electricity. Aeronautics at the Congress of the "Sociétés Savantes" at la Sorbonne. Scientific Commission of Aerostation of Paris. Researches on rarified gases. Obituary (P. de Jouvencil and Henri Widmer). Review of aeronautical publications.

La France Aérienne (Paris), 1—15 April: "The Discovery of Balloons," refutation of the Brazilian and Portuguese Legends; Equilibrium in Dirigible Balloons; "New Flying Machine" (Stenzel's); and other interesting notes. 15—30 April: "Study of the High Regions of the Air;" "Lilienthal;" "An Aerial Voyage," Raymond de Montmorency. 1—15 May: "An Aerial Voyage" (continued), and notes. 15—31 May: "Congress of the Sociétés Savantes," with designs for navigable balloon; "Eray's Navigable Balloon" (illustrated); "The Bordeaux Society of Aerial Navigation;" Notes on the History of Ballooning, &c. 1—15 June: "An Aerial Voyage;" "Macedoine;" Notes. 15—30 June: "Captive Balloon at the Leipsig Exhibition," giving details of the first month's working. Notes.

Réveil de France (Paris) is a new weekly paper devoted to certain subjects, including "Aerostation." The first number (2nd May) contains an article on "The Aeronautical Situation."

L'Aeronauta (Milan), Jan—Mar.: "Liquid Carbonic Acid Motors," with illustration of Stenzel's engine; "The Dominion of the Air;" "Animal and Mechanical Flight;" "Compressed Air Turbines;" "Metallic Balloons," as designed by Lana, Dupuis-Delcourt, Marey-Monge, and Fontana; "Arrigo's Lenticular Balloon;" "Exploration of the High Regions of the Air;" Notes. April—May: "The Lenticular Balloon" of Sig. F. Arrigo (illustrated);" "Metallic Balloons;" "Employment of Explosives as a Motive Force;" "The Theory of Aerial Navigation," by Captain F. Biazzi; "Books and Journals."

Zeitschrift für Luftschiffahrt (Berlin). April. "The Simultaneous Scientific Balloon Ascents of 14th November," giving details of the results obtained. "Experiments with Large Air Propellers," by Prof. G. Wellner (illustrated), an interesting scientific paper. "Experiments on Wind Pressures," by F. Ritter.

Reports of the Upper-Rhine Aeronautical Society. This Society continues to prosper. The membership now amounts to 254 Particulars are given of the Society's new balloon, also the results of the international ascents of 13th May.

Notable Articles.

(*April, May, and June.*)

United Service Magazine, April.—"The Conquest of the Air," by Capt. BADEN-POWELL. This article, though palpably written some years ago, may still be considered as embodying the general status of aerial navigation. It is divided in three parts, headed respectively—"Aviation and Flying Machines," "Ballooning," and "Aerial Warfare." Summarizing shortly what has been accomplished, and what is likely to result from the introduction of any kind of steerable air-craft.

Alte and Neue Welt, April.—"Ballooning." (Illustrated.)

Philadelphia Record, April 3.—"Balloons." International Scientific Ascents.

Sketch, April 7.—Davidson's Flying Machine. (Illustrated.)

Invention, April 10.—"The Aeronautical Society."

Spectator, April 17.—Scientific Kite Flying.—Review of Woglom's "Para Kites."

Army and Navy Gazette, April 17.—"Kites for War Purposes."

Invention, April 24.—"The Mysterious Air Ship."

Black and White, April 24.—"Ballooning," with portraits of Messrs. SPENCER.

Century Magazine, May.—"Scientific Kite Flying," J. B. MILLET (Illustrated); "Experiments with Kites," Lt. H. D. WISE (Illustrated); "Photographing from Kites," W. A. EDDY (Illustrated). These three articles form a most interesting account of what is being done in America with Kites, though the achievements of experimenters in other parts of the world are entirely ignored.

Revue Maritime, May.—"Aerial Currents: Their Course and their Uses for Balloonists." (Cont.)

Spectator, May 1.—"Scientific Kite Flying." Letter from Mr. ARCHIBALD.

Daily Mail, May 3.—"A New Engine of War—Capt. BADEN-POWELL'S War Kite."

English Mechanic, May 14.—"Aerial Navigation." Historical.

Cleveland Leader (U.S.A.), May 16.—"International attempts to solve the problem of Aerial Navigation." (Illustrated.)

Sheffield Weekly Telegraph, May 28.—"Kites in Warfare."

Invention, May 29.—"Aerial Flight."

Toronto Daily Mail, May 29.—"A Great Balloonist." Prof. ANDREE and Polar Ballooning

---

The Strand Magazine, June.—"The New Flying Machine," Prof. LANGLEY. (Illustrated.)

McClure's Magazine, June.—"The New Flying Machine," Prof. LANGLEY. (Illustrated.)

The Rambler, June.—"Our War Balloons." (Illustrated.)

Rocket, June 17.—"Adventures in the Air." The Fates of some Aeronauts.

English Mechanic, June 18.—"Our Teachers in Sailing Flight," O. LILIENTHAL. Reprinted from Aeronautical Annual.

Golden Penny, June 26.—"About Flying Machines." (Illustrated). Historical.

Pall Mall Gazette, June 29.—"A New Experiment in Soaring Flight."

Applications for Patents.

9734. April 16. JOHN MARSHALL, 23, Rockingham Terrace, Birdwell, Barnsley. **An Improved Method of Construction and Application of Wings and Aeroplanes and Appliances Connected therewith for the Purpose of Aerial Navigation.**

9864. April 20. BERNHARD REINARD BEENEN, 89, Chancery Lane. **Improvements in Flying Machines.**

10,620. April 28. HIRAM STEVENS MAXIM, 45, Southampton Buildings. **Improvements in Aerial or Flying Machines.**

10,811. April 30. GUSTAV FRICKE, 18, Southampton Buildings, London. **Improvements in Aerial Balloons.**

13,372. May 31. OCTAVE CHANUTE, 70, Market Street, Manchester. **Improvements in and Relating to Flying Machines.**

13,743. FREDERICK WILLIAM BENNETT, 12, Hawthorne Grove, Penge. **Improved Machine for Flying.**

14,078. June 9. HENRY JOHN CHART, 4, South Street, Finsbury. **Improvements in the Propulsion of Boats and other Vessels, Flying Machines, and the like.**

14,334. June 12. HENRY JENNER DUFFERIN, 33, Chancery Lane. **The Space Traveller, or Self-Lifting Vehicle.**

15,135. June 24. GEORGE CAMERON DOUGLAS, 41, Reform Street, Dundee. (W. H. BLAKENEY, South Africa.) **Improvements in Aeronautic Apparatus.**

15,221. June 25. THOMAS MOY, 8, Quality Court, London. (O. CHANUTE and A. M. HERRING, United States.) **Improvements in or Relating to Means or Appliances for Effecting Aerial Navigation.**

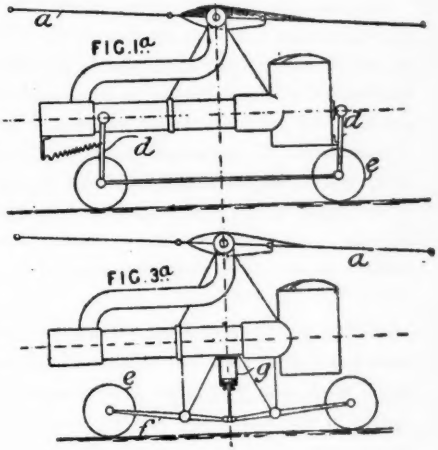
15,278. June 26. WILLIAM CHARLES CHITTY ERSKINE, 27, Southampton Buildings, London. **Improvements in the Method of or Means for Aerial Signalling.**

Patents Published.

From the *Illustrated Official Journal.*

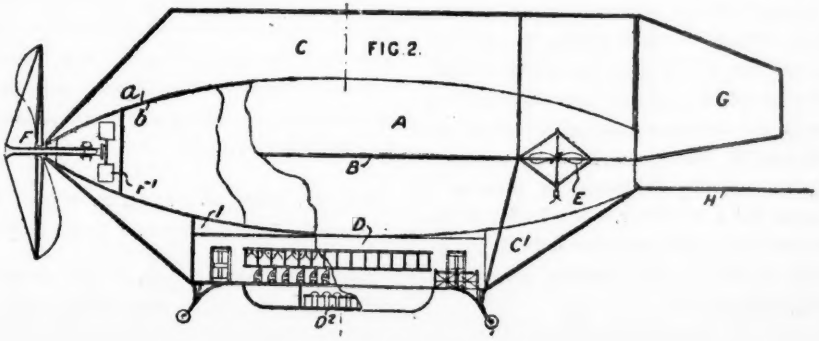
22,011. November 19, 1895. **Aerial Machines.** HOFMANN, J., 1, Lichterfelderstrasse, Berlin.

Starting.—Machines of the kind described in Specifications Nos. 7919 and 11,941, A.D. 1894, are raised from the ground at starting by mounting the machine on rods *d* from the rails *e*. When the machine is moved forward the rods move past the vertical position, and the weight of the machine is taken off the wheels and thrown on the aeroplane *a*. Or the machine may be thrown upwards by attaching the wheels *e*, Fig. 3*a*, by levers *f* to a piston in a steam cylinder *g*.



25,050. December 31, 1895. **Aerial Machine.** PENNINGTON, E. J., Racine, Wisconsin, U.S.A.

One form of the machine is shown in Fig. 2. It comprises a cigar-shaped aerostat A of aluminium, carrying at its bow a propeller F, aeroplanes B on each side, and fins C, C' at top and bottom. There are lifting fans E in the aeroplanes, and vertical and horizontal rudders G and H. A car D is suspended below the aerostat, with a storage chamber below that. In a modification, the car D is in the centre of the aerostat, and the



bow is made more bluff to provide more room for the engines F^1. The whole of the parts, including doors, berths, furniture, are made of aluminium, and inflated with a lighter gas than air. Cushions, footstools, &c., also contain hydrogen.

Aerostats.—The aerostat comprises shells *a*, *b* of sheet aluminium with hydrogen between them; it is stayed by hollow stays and divided by gas tight bulkheads into compartments, an axial tube is provided with manholes leading into each of the compartments. The aerostat is charged by filling it with water or by inflating a bag inside it with air and displacing the water, or causing the bag to collapse by the entrance of the hydrogen. The hollow stays may form the charging pipes.

Propelling and Steering; motors.—The main propeller F is built of sheet aluminium with hollow blades filled with hydrogen. The aluminium shaft *g* is also hollow and conveys air into the engine room. The current of air, thrown rearwards by the propeller F sweeping over the surface of the aerostat, keeps off deposits of moisture, and prevents lateral currents of wind having any effect on it. The motors F are supplied with hydrogen for fuel, which is compressed to the density of the atmosphere and stored in a number of compartments I. On the removal of the hydrogen, the compartments are filled with air of equal weight, and so maintain the balance of the vessel. The thrust of the shaft is taken against a cushion of compressed air in the bearing, kept up by an air pump, and adjusted by the axial motion of the shaft through a relief valve. Four cylinders may be arranged radially around the propeller shaft, and the charge is ignited therein by electricity from the batteries D^2. These batteries also supply current to electromotors for actuating the lifting ans E and the worm gearing for turning the rudders G, H. The steering is effected automatically by controlling the current by means of a compass and a barometer, the oscillation of the compass card or the barometer index finger actuating a switch which reverses the current through the motors.

1877. January 27, 1896. **Aerial Machine.** FRASER, T., 205, Fitzroy Street, St. Kilda, Victoria.

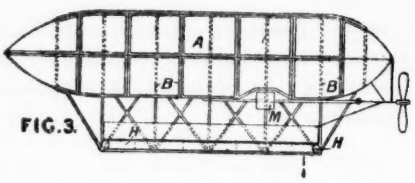


FIG. 3.

The aerostat A is cigar shaped, it is divided into compartments and filled with hydrogen. It is built of aluminium or some other thin metal and is strengthened by tubular bands B which, together with the framework for supporting the car, form the reservoirs for storing the highly compressed ammonia, carbon-dioxide, or combustible gas for use in the rotary motor M. Compressed air ballast is stored in a reservoir H, which is also divided into compartments and strengthened by tubular stays.

ERRATUM.

In the April number of the JOURNAL, for 18,148 read 18,843.

United States Patents.

(Granted April 6th to June 22nd.)

580,941. April 20. HENRY HEINTZ-ELKTON, S.D. **Air-Ship.**

Elongated balloon, having sufficient floating power to very nearly raise the whole weight, with posts depending from it, and a "body," or car, fastened to the lower ends of the posts, parachutes being arranged on each post. Screw propellers and rudders are attached.

582,757. May 18. LOUIS P. MOUILLARD, Cairo, Egypt. **Means for Aerial Flight.**

Soaring machine consisting of an aeroplane composed of two wings, each hinged upon a

vertical axis, and capable of forward and backward movement. Also a mechanical device for throwing forward the tips of the wings, with a spring normally holding the tips of the wings in advance of the axis. The wings adapted to close over one another at will.

French Patents.

260,358. SLY. Improvements Relating to Parachutes.

260,363. SCHNEIDER. New System of Dirigible Balloons.

261,716. VILLON. Flying Apparatus Moved by Human Force.

262,832. BEENEN. Flying Apparatus.

262,957. BAGGE. Method of Directing Balloons.

263,124. HÉBERT. Screw Propeller, Turbine Screw, or Parachute Screw.

263,125. HÉBERT. Flying Apparatus.

263,513. GOURJON. Dirigible Balloon.

263,646. ARSON. Gas Engine for Propelling and Steering Balloons.

German Patents.

(Class 77.)

APPLICATIONS.

ARMIN BECKMANN, Charlottenberg. Elongated Balloon.

CARL EICHLER, Wilhelmstrasse 128, Berlin. Regulating the Rise of Captive Balloons by Means of a Twofold Electric Cable.

GRANTED.

93,184. H. ISRAEL, Schönfelder Str. 15, Dresden. Flying Machine with Perpendicularly Swinging Wings. (June 11, 1896.)

93,387. J. H. HOMEISTER, Borgfelde Malzweg 18, Hamburg. Circular Captive Flying Machine. (February 20, 1896.)

CANCELLED.

70,746, 84,394, 84,567.

Revue Mensuelle

ILLUSTRÉE, DE

l'Aéronautique

Et des Sciences qui s'y rattachent.

Publiee avec la collaboration des principaux savants francais et etrangers.

Directeurs :

Georges BESANÇON et Wilfrid de FONVIELLE.

L'Aérophile, qui compte cinq années d'existence, a des correspondants dans le monde entier.

L'Aérophile est le plus important, le plus répandu, le mieux informé et le mieux illustré de tous les journaux similaires.

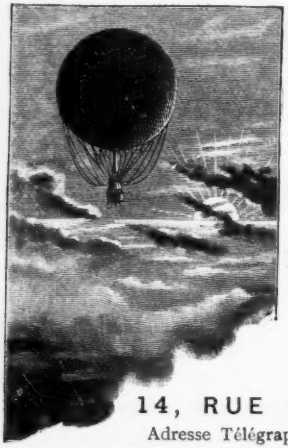
L'Aérophile s'adresse à tous les amis du progrès, même à ceux, et nous osons dire surtout à ceux, que l'étude, pourtant si attrayante, de la navigation aérienne n'a pas encore conquis.

Prix du numéro, UN franc.

ABONNEMENTS : France, un an, 10 fr. ; Union postale, un an, 12 fr.

Rédaction et Administration : — 14, Rue des Grandes-Carrières, PARIS.

Téléphone 503-24.



Etablissement Central d'Aerostation.

Ascensions et Constructions Aéronautiques.

Ballons Captifs à Vapeur.

—: Excursions Aériennes pour Amateurs. :—

Matériel Spécial pour l'Aérostation Militaire.

Lever des Plans Topographiques.

Exploration de la Haute Atmosphère :—

—: Observations Météorologiques, etc.

Georges BESANCON, Directeur,

14, RUE DES GRANDES-CARRIERES, PARIS.

Adresse Télégraphique :—BESANCON, Aéronaute, Paris. Telephone No. 503,24.

L'AERONAUTE,

BULLETIN MENSUEL ILLUSTRÉ - - - - - - DE LA NAVIGATION AÉRIENNE.

Un numero - 75 centimes.

91, RUE d'AMSTERDAM, PARIS.

MAJOR MOORE'S MODEL FLYING MACHINE.